quality and appearance by any of these methods of clarification. This is due to the fact that off-flavors are associated with the solid particles which are removed by clarification.

But this type of product is not the quality product upon which an apple juice industry can be built.

Apple juice should be produced under sanitary conditions from good grade apples. Such juice has a heavy body, a good apple flavor and superior quality. It is such juice upon which an industry can be established.

As a result of our studies we have been able to produce a cloudy apple juice of a light amber color and good body, which has a minimum of sediment and will remain stable in enamel lined cans or suitable bottles for a year or more. Apples of good quality at the proper stage of maturity must be used to give a tart blend of good character. The juice must be handled rapidly to avoid darkening, sedimentation or clarification and enzymic changes. That is, the juice must be deaerated and flash pasteurized at low temperatures rapidly to retain the desired quality.

WHAT'S AHEAD: IV

NEW OUTLETS FROM RESEARCH

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In 1938, Congress directed the Secretary of Agriculture to establish four regional research laboratories to search for new and wider industrial outlets and markets for farm commodities. You have probably read numerous accounts of these new laboratories in the newspapers, and now you are probably asking, "Well, what are you going to do in the Eastern Laboratory?"

I realize that this group is particularly interested in apples and in finding other outlets for them, and what the new Laboratory intends to do for them. However, I believe you would also be interested in a brief discussion of the origin and general set-up of these Regional Laboratories, so that you will see how the program of research on apples fits into the general scheme.

I shall quote a few sentences from this act—"The Secretary is hereby authorized and directed to establish, equip, and maintain four regional research laboratories, one in each major farm producing area, and at such laboratories, to conduct researches into and to develop new scientific, chemical and technical uses and new and extended markets and outlets for farm commodities and products and by-products thereof. Such research and development shall be devoted primarily to those farm commodities in which there are regular or season surpluses, and their products and by-products." That paragraph is the guiding star to which we must keep our research wagon hitched in order to keep it on its intended course.

For many years, and especially during the last few, the Department of Agriculture has been deeply concerned with the problem of surplus crops. Among the agricultural products that have had, with a recurring frequency, the tendency to be produced in surplus quantities are cotton, wheat, corn, peanuts, sweet potatoes, tobacco, fruits and vegetables, milk products, and alfalfa. The searching for new and wider industrial outlets and markets for farm products through research is just one of the several lines of attack on our national farm problem. This means not simply research on specific problems as they arise, but a comprehensive, concerted, closely-knit, aggressive program of research—chemical, physical, technological, and economic—all carried on with the specific aim of finding new and extended uses for farm commoditites.

Thus, it is proposed to make a technological attack on the surplus problem just as a factory would if it saw a large residue or by-product accumulating. This job is so big, it covers such a big territory, and in a sense it is really such a new venture, that it had to be gone about in a systematic way.

As a preliminary step to the setting up of these laboratories, the Department organized a special staff of workers, thoroughly experienced in research work. The members of this staff visited every State, interviewing representatives of private and public research laboratories, educational institutions, and agricultural organizations. There was thus obtained a knowledge of the extent and nature of present research activities in the United States, and also many hundreds of suggestions regarding needed research on various farm commodities. Such information as this is proving invaluable in avoiding duplication of effort and is guiding us in the selection of specific research projects.

The selection of the cities in which the laboratories are being located was based partly on the physical and scientific requirements of the work, partly upon accessibility to the major farm producing areas, and partly upon the possibility of establishing relationships with the agricultural processing industries.

The Western Regional Laboratory is located near San Francisco; the Southern at New Orleans; the Northern at Peoria, Illinois; and the Eastern at Wyndmoor, just north of Philadelphia. Building operations were begun last summer and they will be completed some time this coming summer.

The Eastern Laboratory is being built on a 32-acre tract of land at Wyndmoor, Pennsylvania, which is just north of Philadelphia. This location is accessible to the great processing industries along the Delaware River, and to reference libraries and research activities at the University of Pennsylvania and the Franklin Institute.

The third step in the organization of the laboratories was to assign particular commodities to each of the laboratories. The Northern Laboratory was given wheat, corn, and agricultural wastes, particularly straw, corn stalks, and

cobs. To the Western Laboratory was assigned fruits, vegetables, white potatoes, wheat, and alfalfa. The southern Laboratory will work on cotton, peanuts, and sweet potatoes. To the Eastern Laboratory was assigned apples, tobacco, milk, white potatoes, vegetables, and animal fats.

This is a formidable and disturbing list. It includes all that we smoke, almost all that we eat, and a good deal of what we wear.

You want to discuss apples this afternoon, and so do I, because apples are one of my own primary concerns in the Eastern Laboratory.

One unique thing about apples is that while there is a big concentration of orchards in the eastern states and another in the northwest, they are grown in commercial quantities in almost every state in the Union. The question naturally arose as to which laboratory the work on apples should be assigned. The varieties grown in the East differ somewhat from those grown in the West. Most of the apple products, such as cider, vinegar, and pectin, are made in the East. All things considered, it was deemed best to work on apples in both the Western and Eastern Laboratories. It really doesn't make very much difference, since the results of any laboratory will be available for everyone.

There is already a great variety of products serving as outlets for cull and surplus apples but their production has not kept pace with recent developments. As early as 1908, the Department of Agriculture published results of experiments on the preparation of unfermented apple juice. This referred mainly to putting up cider in barrels, but the cider barrel has disappeared along with the cracker barrel. Modern living necessitates modern packaging. Apple juice must be dressed like its relatives—tomato, citrus, and pineapple juice. If apple juice can be processed to retain indefinitely the flavor of sweet cider a few days from the press, its popularity will be extended from the few months in the fall when good cider is available through the summer months when a thirst-quenching fruit drink is greatly desired.

Methods of concentrating apple juice with recovery of the flavoring constituents have been developed in the laboratory, but they have not received commercial adoption because of certain difficulties in operation. Pilot plant scale experiments are necessary to iron out the kinks and design smoothly operating equipment. The Yearbook for 1912 describes a method of concentrating cider by freezing out the water as ice. One difficulty encountered was the high viscosity of concentrated juices at low temperatures due to the pectin content and the consequent loss of juice in the discarded ice. Methods of removing the pectin by enzyme treatment should aid in overcoming this difficulty and the design of suitable equipment might render the process commercially feasible.

When the acidity of concentrated apple juice is partially neutralized, a table sirup with an apple flavor is obtained. Unfortunately, present methods produce a dark, cloudy, and unattractive product and may even impair the taste. A wide market might be developed for a table sirup with a good apple flavor.

Apple sauce has been used in bread making to produce a quicker fermentation and to prevent ropiness in the dough and to delay staling in the loaf. Certain dried apple sauce products offer possibilities of producing low cost products in convenient form which might extend such a use.

Many bakeries prefer to have apples for pies prepared at a central location where advantages can be had of machinery and proper selection of varieties and grade. Were it not for the darkening and toughening which apple slices undergo during storage in a frozen condition they might be efficiently prepared, stored, and distributed in this condition, with better standardization of the product in convenient form and with the availability of the waste for by-product manufacture.

The first work in this country directing attention to pectin in apple pomace was carried out in the Bureau of Chemistry and published as Bulletin No. 94 in 1905. It was not until after the World War that commercial manufacture was undertaken. Present pectin plants have capacities much larger than that at which they now operate. The chief single outlet is pectin for jelly and jam manufacture although other uses have been suggested and tried such as that of an emulsifier or gum in flavoring and pharmaceutical preparations, in medicine, in dairy, confectionary, and bakery products, in plastics, in sizing textiles and in quenching steel. Uses might be extended by investigating outlets where jellying properties, and purity for food uses, are not important. This would permit manufacture at a lower cost and greatly broaden the field of application. Uses for derivatives of pectin such as polygalacturonic acid and its salts might be found. Promising methods exist for the large scale manufacture of galacturonic acid from pectin should uses be found for this substance.

May I emphasize that in our work we will not stop at the test tube stage of research. Any findings in the laboratory that look at all promising will be transferred to a pilot plant scale of operation. This is the invariable procedure in industry when a new product is developed. The pilot plant equipment will be large enough to make a study of the probable type of equipment required, the materials of construction, and the behavior of the product in large bulk. Enough of the product will be made so that a thorough study of its usefulness and marketability can be made. To quote the old maxim: "Make your mistakes in a small plant, and your profits in a big plant."

May I further emphasize that we welcome suggestions and ideas from apple growers and apple processors. The above are our ideas at present. We certainly expect to have more ideas as our work progresses, and as we make contact with the apple industry.